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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/500,494	12/27/2004	Hyung-Sang Park	9907-007	4487

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EXAMINER

PHAM, THANH V

ART UNIT PAPER NUMBER

2823

DATE MAILED: 11/13/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	Application No.	Applicant(s)	
	10/500,494	PARK ET AL.	
	Examiner	Art Unit	
	Thanh V. Pham	2823	

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 21 July 2006.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-3, 5-7, 9-13, 15-17 and 21-28 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-3, 5-7, 9-13, 15-17 and 21-28 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)          | 4) <input type="checkbox"/> Interview Summary (PTO-413)           |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____                                      |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)          | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____  | 6) <input type="checkbox"/> Other: _____                          |

## DETAILED ACTION

### *Response to Amendment*

1. The amendment (to the specification and the claims) overcomes the objections to the specification and claims 3, 8, 13 and 18 and the rejection under 35 U.S.C. 112, second paragraph to claim 20. The above objections and rejection have been withdrawn.

### *Claim Rejections - 35 USC § 102*

2. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.
3. Claims 10-11 and 16-17 are rejected under 35 U.S.C. 102(a) as being anticipated by Soininen et al. US 6,482,740 B2.

Re claim 10, the Soininen et al. reference discloses in fig. 1 a method for forming copper interconnect comprising:

forming a barrier layer 14 on the surface of a patterned insulation layer 6/8/10/12 on a substrate 2/4;

forming an adhesion layer 16 on said barrier layer using ruthenium or ruthenium alloys by using an atomic layer deposition method

col. 7, lines 21-36: "...a substrate with open trenches and vias is provided into an ALD reaction chamber. A diffusion barrier layer 14 is on the surfaces of the substrate... A metal oxide thin film is grown on the diffusion barrier 14 from alternate pulses of a metal source chemical and oxygen source chemical... The metal oxide film is reduced into a metal layer and used as a seed layer 16 for an electroplating process";

and forming a copper layer 18 on the surface of said adhesion layer using CVD

col. 3, lines 15-35: "alternatives for copper electroplating (step 9) are electroless plating, physical vapor deposition (PVD) and chemical vapor deposition (CVD). A seed layer (c.f Step 8) is only needed for the electroplating process. Traditionally such a seed layer is deposited by chemical vapor deposition (CVD) ... One can envision a seed layer that acts as a nucleation layer for the CVD process."

Re claim 11, the barrier layer is TaN, col. 5, line 51.

Re claim 16, forming said copper layer further comprises using an electroplating method (step 9. Vias and trenches are filled with copper by an electroplating process, col. 3, lines 6-7).

Re claim 17, forming said copper comprises sequentially using CVD followed by the electroplating method (the "alternatives" as extracted above).

***Claim Rejections - 35 USC § 103***

4. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

5. Claims 1 and 6-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soininen et al. US 6,482,740 B2 in combination with Toyoda et al. US 2001/0013617 A1.

Re claim 1, the Soininen et al. reference discloses a method for forming copper interconnect as in the above, an adhesion layer 16 on said barrier layer using ruthenium or ruthenium alloys by using an atomic layer deposition method, and further:

"inert metals, such as platinum group metals, or conductive metal oxides, such as RuO<sub>2</sub>, must be used adjacent to the high-k metal oxides" (col. 4, lines 16-19).

"the manufacture of conductive thin films, preferably comprising one or more of the following elements: *rhenium*, *ruthenium*, osmium ... iridium, nickel ... platinum ... a metal oxide layer by an ALD type process and essentially

converting the metal oxide into an elemental metal to provide sufficient conductive for the thin film. A surprising finding related to the present invention is that the film has very good adhesion to the substrate, even after a reduction step" (col. 5, lines 5-25).

The Toyoda et al. reference discloses in [0138] "ruthenium is known to be effective as a diffusion barrier (barrier film) against copper... the thermal diffusion of copper into the interlayer insulating film can be prevented".

It would have been obvious to one of ordinary skill in the art at the time of the invention to consider the ruthenium adhesion layer 16 of Soininen et al. as barrier as taught by Toyoda et al. because the ruthenium of Soininen et al. would have the function of a barrier film with prevention of thermal diffusion of copper into the interlayer insulating film as taught by Toyoda et al.

Limitations in claims 6-7 are considered as claims 16-17 above.

6. Claims 2-3, 5 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Soininen et al./Toyoda et al. as applied to claims 1 and 6-7 above, and further in view of Kim et al. US 6,936,535 B2, Koh et al. US 6,720,262 B2.

The combination discloses substantially all of the instant invention but lacks the atomic ratio of ruthenium or rhenium in an alloy (re claims 2 and 9), PE-ALD (re claim 3) and iodine or an iodine compound as a catalyst for copper CVD (re claim 5).

Re claim 3, the Kim et al. reference discloses "the reactive metal layer may also be deposited by any method known in the art, such as by PVD, CVD, ALD or plasma enhanced ALD (PE-ALD) processes" (col. 10, lines 24-26).

It would have been obvious to one of ordinary skill in the art at the time of the invention to apply known plasma enhanced ALD (PE-ALD) processes because plasma

enhanced ALD (PE-ALD) processes would provide the atomic layer deposition of the combination of Soininen et al./Toyoda et al. with an equivalent "self-limitingly, no more than a monolayer" at a time as taught by Kim (col. 9, lines 64-65).

Re claim 5, the Koh et al. reference discloses "in a first aspect of the present invention, a method of using iodine or bromine as a catalyst in conjunction with a copper CVD method in filling trenches, via holes and contacts without creating undesirable pinch-offs and voids is disclosed and presented" (col. 2 lines 45-53).

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide the method of the combination with iodine as a catalyst in conjunction with a copper CVD because iodine as a catalyst in conjunction with a copper CVD would provide the method without creating undesirable pinch-offs and voids as taught by Koh et al.

Re claims 2 and 9, choice of ratio of elements would have been a matter of routine optimization because ratio of elements is known to affect device properties and would depend on the desired device density on the finished wafer and the desired device characteristics. One of ordinary skill in the art would have been led to the recited ratio of elements, 50% or more Ru or Re in the alloys, through routine experimentation to achieve desired deposition and reaction rates.

7. Claims 12-13 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soininen et al. as applied to claims 10-11 and 16-17 above, and further in view of Kim et al. US 6,936,535 B2, Koh et al. US 6,720,262 B2 and the following.

The Soininen et al. discloses substantially all of the instant invention but lacks the atomic ratio of ruthenium or rhenium, PEALD and iodine as a catalyst for copper CVD.

Re claim 13, the Kim et al. reference discloses "the reactive metal layer may also be deposited by any method known in the art, such as by PVD, CVD, ALD or plasma enhanced ALD (PE-ALD) processes" (col. 10, lines 24-26).

It would have been obvious to one of ordinary skill in the art at the time of the invention to apply known plasma enhanced ALD (PE-ALD) processes because plasma enhanced ALD (PE-ALD) processes would provide the atomic layer deposition of the combination of Soininen et al./Toyoda et al. with an equivalent "self-limitingly, no more than a monolayer" at a time as taught by Kim (col. 9, lines 64-65).

Re claim 15, the Koh et al. reference discloses "in a first aspect of the present invention, a method of using iodine or bromine as a catalyst in conjunction with a copper CVD method in filling trenches, via holes and contacts without creating undesirable pinch-offs and voids is disclosed and presented" (col. 2 lines 45-53).

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide the method of the combination with iodine as a catalyst in conjunction with a copper CVD because iodine as a catalyst in conjunction with a copper CVD would provide the method without creating undesirable pinch-offs and voids as taught by Koh et al.

Re claim 12, choice of ratio of elements would have been a matter of routine optimization because ratio of elements is known to affect device properties and would depend on the desired device density on the finished wafer and the desired device

characteristics. One of ordinary skill in the art would have been led to the recited ratio of elements, 50% or more Ru or Re in the alloys, through routine experimentation to achieve desired deposition and reaction rates.

8. New claims 21-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soininen et al. in combination with Toyoda et al. as applied to claims 1 and 6-7 above, and further in view of Gelatos et al. US 5,391,517.

Also new claims 25-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soininen et al. as applied to claims 10-11 and 16-17 above, and further in view of Gelatos et al. US 5,391,517.

The above combination Soininen et al./Toyoda et al. and Soininen et al. alone disclose substantially all of the instant invention but lack CVD using a carbon-containing or fluorine-containing copper precursor or using a copper precursor comprising (hexafluoroacetylacetonate hfac) (Cu copper) (vinyltrimethylsilane vtms).

The Gelatos et al. reference discloses (hexafluoroacetylacetonate hfac) (Cu copper) (vinyltrimethylsilane vtms) is used in CVD process to deposit copper into trenches.

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide (hexafluoroacetylacetonate hfac) (Cu copper) (vinyltrimethylsilane vtms) as a carbon-containing or fluorine-containing copper precursor or a copper precursor comprising (hexafluoroacetylacetonate hfac) (Cu copper) (vinyltrimethylsilane vtms) because (hfac)Cu(vtms) would be selected in accordance with the Cu CVD process as taught by Soininen et al./Toyoda. The use of (hfac)Cu(vtms) as copper



precursor (carbon-containing or fluorine-containing) for CVD is well known to those skill in the art as taught by Gelatos et al.

***Response to Arguments***

9. Applicant's arguments filed 07/21/2006 have been fully considered but they are not persuasive.

10. In response to applicant's argument that "Soininen did not realize the contamination problem", a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim.

11. With the added limitation from canceled claim 14 into claim 10, applicant argues that "Soininen neither teaches nor suggests the limitations of amended claim 10" and the combining of two separate teachings in Soininen is not proper for a rejection under 35 U.S.C. 102(a). This assertion is not agreed by the following reason. The sequence of steps in the "Background" of Soininen is the complete process while the invented method of Soininen concentrates on the two steps 7 and 8. After these two step of Soininen's invention, the method would be continue by proceeding through step 9, and so on, to complete the process (Soininen's col. 7). This is the improvement in forming the "seed" and/or adhesive/barrier layer in the known process sequence. What is the use of the formed barrier and seed layers? Soininen's invention cannot stop there. Therefore, it is not a "combining two separate teachings" as alleged.

12. Further, in response to applicant's argument that Soininen's preferred embodiment is different from instant invention, this argument is respectfully traversed because, although not taught as a preferred embodiment, Soininen teaches this embodiment nonetheless, and disclosed examples and preferred embodiments do not constitute a teaching away from a broader disclosure or nonpreferred embodiments. In *re Susi*, 169 USPQ 423 (CCPA 1971). "A known or obvious composition does not become patentable simply because it has been described as somewhat inferior to some other product for the same use." In *re Gurley*, 31 USPQ2d 1130, 1132 (Fed. Cir. 1994). A reference may be relied upon for all that it would have reasonably suggested to one having ordinary skill the art, including nonpreferred embodiments. *Merck & Co. v. Biocraft Laboratories*, 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir.), cert. denied, 493 U.S. 975 (1989). Even a teaching away from a claimed invention does not render the invention patentable. See *Celeritas Technologies Ltd. v. Rockwell International Corp.*, 150 F.3d 1354, 1361, 47 USPQ2d 1516, 1522-23 (Fed. Cir. 1998), where the court held that the prior art anticipated the claims even though it taught away from the claimed invention. "The fact that a modem with a single carrier data signal is shown to be less than optimal does not vitiate the fact that it is disclosed." To further clarify, a prior art opinion that a claimed invention is not preferred for a particular limited purpose, does not preclude utility of the invention for that or another purpose, or even preferability of the invention for another purpose.

**Conclusion**

13. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

14. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.


15. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh V. Pham whose telephone number is 571-272-1866. The examiner can normally be reached on M-Th (6:30-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith can be reached on 571-272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

*WSP*

09/19/2006

  
George Fourson  
Primary Examiner